DOCUMENT RESUME

ED 161 679 SE 024 993

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|---|---|
| AUTHOR | Lawrenz, Frances |
| TITLE | The Relationship Between Teacher Characteristics and Student Achievement and Attitude. Research Paper No. 8. |
| INSTITUTION | Minnesota Univ., Minneapolis. Coll. of Education. |
| SPONS AGENCY | National Science Foundation, Washington, D.C. |
| PUB DATE | [75] |
| GRANT | NSF-GW-6800 |
| NOTE | 20p.; For related documents, see SE 024 989-999 and ED 148 632-640; Contains occasional light and broken type |
| EDRS PRICE | MF-$0.83 HC-$1.67 Plus Postage. |
| DESCRIPTORS | *Academic Achievement; *Educational Research; Science Education; *Science Teachers; Secondary Education; Student Attitudes; Student Teacher Relationship; *Teacher Characteristics; Teacher Influence; Teacher Motivation |
| IDENTIFIERS | *Minnesota Research & Evaluation Project; National Science Foundation; Research Reports |

ABSTRACT

This research study sought to determine the extent of the relationship between teacher characteristics and student outcomes and to provide an indication of the order of importance among the teacher characteristics. A stratified random sample was selected of 236 secondary science teachers including 84 biology teachers, 111 chemistry teachers, and 41 physics teachers from 14 states. The selected science teachers completed four instruments. Each teacher randomly selected one of his/her classes to complete four instruments. Stepwise regression and canonical correlation were used to analyze the data. Results showed that the selected teacher characteristics accounted for one-fifth to one-third of the total variance in student scores. It was also indicated that the self-improvement variable seemed to be the most consistent predictor for student outcomes. (HM)

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RESEARCH PAPER #8

# The Relationship Between Teacher Characteristics and Student Achievement and Attitude

Frances Lawrenz

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This study was supported by grant GW-6800 from the National Science Foundation to the University of Minnesota. Wayne W. Welch, Project Director.

# THE RELATIONSHIP BETWEEN TEACHER CHARACTERISTICS AND STUDENT ACHIEVEMENT AND ATTITUDE

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The trend in teacher education today is toward a competency-performance based instructional system. Practically, this means that teacher education should involve more instruction on actually how to teach. In order to accomplish this, the art and science of teaching must be critically examined and the effective teacher characteristics carefully identified. Whenever possible the characteristics contributing to effective teaching must be described in behavioral terms so that novice teachers may emulate them and hopefully become effective teachers themselves.

Before these behaviors can be identified, the criteria of successful teaching must be determined. As Peck and Tucker suggest in the Second Handbook of Research in Teaching,[1] the ultimate test of teacher effectiveness should be its consequences for students. Since two generally accepted, desirable consequences of education are increased in student achievement and improvement in student attitude, these could serve as criteria of successful teaching. Therefore, teacher educators should try to identify particularly those teacher characteristics that help students achieve these goals.

As summarized in the Second Handbook of Research in Teaching,[1] most recent studies relating teacher behavior to student improvement have shown that specific types of teacher training do have an effect. These studies

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*This study was supported by grant GW-6800 from the National Science Foundation to the University of Minnesota. Wayne W. Welch, Project Director.

examined differences between students of teachers who had a certain type of training and students of teachers who had not had it. While this type of information is important, it is also necessary to determine some type of ranking among the various teacher behaviors and some indication of how much these behaviors actually contribute to student learning. Without knowledge of the relative importance of the particular characteristics all would be stressed equally, whereas, with this knowledge teacher educators would be able to concentrate their efforts on student mastery of the more important skills. This would provide for a more efficient use of time and energy.

The purpose of this investigation was to determine the extent of the relationship between teacher characteristics and student outcomes and to provide an indication of the order of importance among the teacher characteristics.

## Procedure

This study employed two statistical procedures to examine the relationships between student and teacher characteristics and to provide information on the rank and contribution of the teacher variables. One procedure was stepwise regression which provides an ordered linear combination of dependent variables and a summary of the independent variable variance accounted for. The other procedure was canonical correlation which assesses the character of the relationship between two sets of variables. While the regression examined one student outcome at a time, the canonical correlation provided information on the overall relationship between all student outcomes and all teacher characteristics. Because of the nature of these procedures, this study was exploratory rather than definitive, but it may identify profitable areas for more intensive controlled research.

The data for this study were obtained from a stratified random sample of 236 secondary science teachers from 14 states of which 84 were biology teachers, 111 were chemistry teachers, and 41 were physics teachers. The 14 states were stratified by city size and a percentage of the schools from each population and were randomly selected. The selected science teachers completed a questionnaire, the National Teachers Exam (NTE) in Science (Educational Testing Service), the Science Process Inventory (SPI),[2] and the Science Attitude Inventory (SAI).[3] Each teacher randomly selected one of his classes to complete four instruments: the Learning Environment Inventory (LEI),[4] the Test on Achievement in Science (TAS) compiled from the released National Assessment of Science items, the SPI and the SAI. Table 1 lists the reliabilities of the instruments of the study.

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Insert Table 1 About Here

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In order to make the teachers more receptive to participation, the testing was completed in one class period, utilizing the randomized data collection procedure described by Walberg and Welch.[5] Under this procedure the unit of analysis was the class mean score on each instrument. The response rate for the initial request for participation was 60 percent. A non-respondent study showed no differences between the respondents and the non-respondents on several selected variables.[6]

The criteria selected for determining the contribution and rank of the teacher characteristics were student achievement and attitude. These student attributes were measured by their scores on the TAS, SPI and SAI.

TABLE 1

Instrument Reliabilities

| Instrument | Method of Assessment | Reliability |
|---|---|---|
| SAI | Test-retest | .93 |
| SPI | Kuder-Richardson #20 | .90 |
| TAS | Kuder-Richardson #20 | .87 |
| NTE | Not Available | .90 |
| LEI (Goal Direction) | Cronbach's Alpha | .85 |
| LEI (Formality) | Cronbach's Alpha | .76 |
| LEI (Democratic) | Cronbach's Alpha | .67 |

The next step is the identification of the teacher characteristics. The two main requirements of students in teacher education programs are courses in their prospective subject area and courses in teaching methods. Apparently knowledge of subject matter and instruction in how to teach are believed to help create better teachers. Therefore, these variables were included. Knowledge of subject matter was measured by teacher NTE and SPI scores and number of credits in teaching methods was obtained from the questionnaire.

Examination of previous research suggested two more teacher characteristics. Since several investigations have shown conflicting results for the effect of experience, data on that characteristic which were obtained from the questionnaire were included.[7,8,9] Student interest in science has been reported by Wynn and Bledsoe[10] to be affected by teachers. Therefore, teacher scores on the SAI were also included.

Hopefully, any attempts at professional self-improvement, like attendance at institutes, graduate work, participation in professional organizations, and use of classroom self-evaluation procedures, would be positively related to student learning. Items pertaining to these types of activities were included in the questionnaire and were combined to create a self-improvement variable for this investigation.

The Second Handbook of Research in Teaching[1] suggested that the social climate of the classroom is an important contributor to student outcomes. In many studies the LEI has been proven to be a valid and reliable instrument for assessing this social climate. Two of its scales, Formality and Goal Direction, have been shown to be related to teacher personality. A third[11]

scale, Democratic, seemed pertinent because of the current emphasis on student controlled learning. Therefore, the class mean scores for these three scales were included as measures of teacher characteristics.

These considerations resulted in the nine teacher characteristics: NTE score; SPI score; number of credits in teaching methods; number of years of experience; SAI score; self-improvement score; Formality score; Goal Direction score; and Democratic score; which were correlated with the student scores for the TAS, SPI and SAI.

## Results

Tables 2, 3, and 4 show the order in which the nine teacher variables contributed to the student achievement (TAS and SPI) and attitude scores (SAI). As shown by the R square values, these teacher characteristics accounted for 23 to 32 percent of the variance in the student scores. Fairly low R square values were to be expected because of student variables and perhaps some of the variance could be explained by differences that exist between the three science courses. Possible differences due to the type of course were investigated by repeating the analysis with the data divided into biology, chemistry, and physics classes. However, the results showed no real increase in the R square values. Teacher characteristics seem to predict one-fifth to one-third of the student variance.

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Insert Tables 2, 3, and 4 About Here

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Each table contains two sets of F values. One, the F value for coefficients, is the F value for the significance of the individual B values for each teacher variable. The other F values, the F value for inclusion,

TABLE 2

Student Achievement (TAS)

| Teacher Characteristic | Beta | B | Standard Error of B | F Value for Coefficient* | R Squared | F Value for Inclusion** |
|---|---|---|---|---|---|---|
| SPI Score | .34 | .22 | .07 | 11.40† | .13 | 20.56† |
| Self-Improvement | .18 | .11 | .05 | 4.41† | .20 | 16.88† |
| LEI Formality | -.33 | -6.65 | 1.69 | 15.54† | .25 | 14.70† |
| LEI Goal Direction | .20 | 3.36 | 1.54 | 4.76† | .28 | 12.63† |
| NTE Score | -.16 | - .01 | .01 | 2.60 | .30 | 11.15† |
| Number of Years Teaching Experience | .14 | .09 | .05 | 2.75 | .32 | 9.86† |
| SAI Score | .07 | .03 | .03 | .74 | .32 | 8.55† |
| Number of Credits Teaching Methods | .03 | .02 | .05 | .17 | .32 | 7.45† |
| LEI Democratic | .03 | 1.07 | 3.29 | .11 | .32 | 6.58† |

*D.f. for numerator = 1; d.f. for error = 124.

**D.f. for numerator = rank of inclusion; d.f. for demoninator = 124.

†Significant at $p < .05$.

TABLE 3

Student Achievement (SPI)

| Teacher Characteristic | Beta | B | Standard Error of B | F Value for Coefficient* | R Squared | F Value for Inclusion** |
|---|---|---|---|---|---|---|
| SPI Score | .25 | .33 | .14 | 5.34† | .10 | 14.19† |
| Self-Improvement | .11 | .14 | .11 | 1.51 | .14 | 10.49† |
| LEI Formality | -.23 | -9.49 | 3.66 | 6.74† | .16 | 8.09† |
| Number of Years Teaching Experience | .17 | .21 | .11 | 3.36 | .18 | 6.99† |
| LEI Goal Direction | .16 | 5.52 | 3.34 | 2.73 | .20 | 6.48† |
| NTE Score | -.05 | - .01 | .10 | .17 | .20 | 5.42† |
| SAI Score | .04 | .03 | .07 | .18 | .20 | 4.64† |
| Number of Credits Teaching Methods | .04 | .04 | .10 | .18 | .21 | 4.05† |
| LEI Democratic | .02 | 1.71 | 7.12 | .06 | .21 | 3.58† |

*D.f. for numerator = 1; d.f. for error = 124.

**D.f. for numerator = rank of inclusion; d.f. for demonimator = 124.

†Significant at $\rho < .05$.

TABLE 4

Student Attitude (SAI)

| Teacher Characteristic | Beta | B | Standard Effor of B | F Value for Coefficient* | R Squared | F Value for Inclusion** |
|---|---|---|---|---|---|---|
| SPI Score | .33 | .33 | .11 | 9.50† | .08 | 11.57† |
| Self-Improvement | .17 | .16 | .08 | 3.56† | .04 | 10.37† |
| NTE Score | -.24 | - .02 | .01 | 5.00† | .17 | 8.57† |
| LEI Goal Direction | .21 | 5.41 | 2.53 | 4.57† | .19 | 7.50† |
| LEI Formality | -.19 | -6.04 | 2.77 | 4.74† | .21 | 6.99† |
| SAI Score | .09 | .06 | .06 | 1.06 | .22 | 5.99† |
| Number of Years Teaching Experience | .06 | .06 | .09 | .51 | .22 | 5.20† |
| Number of Credits Teaching Methods | .05 | .05 | .08 | .37 | .23 | 4.57† |
| LEI Democratic | .03 | 1.65 | 5.40 | .09 | .23 | 4.04† |

*D.f. for numerator = 1; d.f. for error = 124.

**D.f. for numerator = rank of inclusion; d.f. for denominator = 124.

†Significant at $\rho < .05$.

are the sequential values for the addition of each variable to the regression equation. Draper and Smith[12] suggested that for a variable to be a good predictor its F value for inclusion should be four times the value for the desired significance level. Taking both of these values into consideration, four variables can be identified as the most important: Self-Improvement, National Teacher Exam score, LEI scales of Formality and Goal Direction, and Science Process Inventory score.

The first canonical covariate was significant at $\rho < .01$. There were no others that were significant. The canonical correlation between the set of student characteristics and the set of teacher characteristics was .61. Apparently these two sets are related to each other. The coefficients for the canonical variables are presented in Table 5. It should be noted that, since the two student achievement measures were negative, coefficients vary directly with student achievement and inversely with student attitude. Because the attitude coefficient was low, its relationships should be viewed cautiously. Examination of the teacher coefficients yielded four characteristics, the LEI scales of Formality and Goal Direction, Self-improvement, and SPI score, that were fairly highly related to the student variables. With the exception of NTE scores, these were the same characteristics identified by the regressions.

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Insert Table 5 About Here

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## Discussion

While the teachers' score on the SPI was the best predictor in the three regressions, it did not rate as high on the canonical analysis or in

TABLE 5

Coefficients for the Canonical Variables

| Student Characteristics | | Teacher Characteristics | |
|---|---|---|---|
| TAS | -.77 | Formality | .61 |
| SPI | -.42 | Self-Improvement | -.43 |
| SAI | .14 | SPI | -.41 |
| | | Goal Direction | -.40 |
| | | Years of Experience | -.25 |
| | | SAI | -.19 |
| | | NTE | .17 |
| | | Teaching Methods Credits | .08 |
| | | Democratic | -.07 |

the supplementary regressions completed for the individual science courses. Perhaps there are some differences among the science teachers in the different courses that affected their SPI scores. However, this teacher characteristic was obviously highly related to student achievement and attitude and could be investigated further, perhaps through the use of controlled experiments within individual science courses.

The two LEI scales provided interesting results. Apparently a class that is goal directed has high student achievement. This may be some evidence for the usefulness of stating objectives. The students might know more about what is expected of them and, therefore, accomplish more. However, this goal directing should not become formalized into strict rules, since the Formality scale showed an inverse effect on student achievement.

The situation regarding the relationship of student attitude to these two scales was contradictory. The canonical analysis showed attitude as directly related to formality and inversely related to goal direction, while the regression analysis provided the opposite result. Because the canonical attitude coefficient was low, the regression results were probably more accurate. The interpretation provided by the regression also seemed logical since a student might feel secure and therefore happy in a goal directed situation but restricted in a too formalized one.

The self-improvement variable seemed to be the most consistent predictor. It has several components but they were all related to the teacher's desire to improve himself within his profession. Its high relation to student outcomes was consistent with other research on teacher characteristics, which generally holds that the teacher's personality is one of the most

significant teacher variables relating to student outcomes. Perhaps any new investigations on teacher personality should contain scales which measure desire for self-improvement.

By considering those teacher characteristics that were shown to be most related to student outcomes, an image of the type of teacher who is likely to have a class of high achieving students emerges. The word that seems to best describe this type of teacher is ambitious. A teacher who is ambitious would certainly rank high on the professional self-improvement variable. This extra work improving teaching techniques, along with their usually high SPI scores, could make the teacher more confident of his teaching ability and therefore less likely to require a strict, formalized, classroom situation. Usually ambitious people have definite goals in mind that they are striving for. It is possible that this goal directedness would carry over into the classroom. Further, because ambitious people are likely to be flexible in order to take advantage of any situation, it is possible that the classroom situation they create would be less strict and more apt to be changeable.

## Conclusions

In general, this exploration showed that the selected teacher characteristics accounted for one-fifth to one-third of the total variance in student scores. There are obviously other variables, both student and teacher, that could be used in predicting. The reader is cautioned against generalizing these results to other fields because science teachers and classes have been shown to differ from teachers and classes in other areas.[4,7]

What are the implications for teacher educators? 1) They need to determine how to instill a desire for self-improvement in their students. The new teachers should be proud of their profession and want to succeed at it. 2) They need to consider the importance of the type of organizational pattern that the new teachers will impose on their classes. Classrooms should be goal directed but not too strict. 3) They need to insure that their students have an adequate background in their specific field along with a basic understanding of the underlying processes of science.

Some areas in which further research might be profitable can be identified. First, of course, similar investigations could be completed for other academic areas. Because these science teacher characteristics have been shown to be related to student outcomes, a logical next step would be to investigate cause-effect relationships. For example, science student gain scores on achievement and attitude measures in high and low goal directed or formal classes could be compared through the use of F tests. Although teacher SPI score was shown to be related to student outcomes, its relationship seems to be confounded with a class effect. Possible differences between the various science classes and their teachers' knowledge of science processes should be identified and investigated. Because the most consistent result was the relationship of teacher desire for self-improvement with student outcomes, classes with teachers of different professional ambition levels should be compared and the various components that make up this variable should be investigated individually.

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